

D.6.1.3.2 Designing Adaptation Policy Trajectories



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About DECCMA Working Papers

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Titles in this series are intended to share initial findings and lessons from research studies commissioned by the program. Papers are intended to foster exchange and dialogue within science and policy circles concerned with climate change adaptation in vulnerability hotspots. As an interim output of the DECCMA project, they have not undergone an external review process. Opinions stated are those of the author(s) and do not necessarily reflect the policies or opinions of IDRC, DFID, or partners. Feedback is welcomed as a means to strengthen these works: some may later be revised for peer-reviewed publication.

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1. Introduction

In deltas in the global south, environmental and climatic variability and change hinder present day and future attainment of development goals and create dangerous living conditions. There is a pressing need for information about how current and future stresses and shocks might affect development potential within deltas, and what people and governments can do to adapt. The ‘Deltas, Vulnerability & Climate Change: Migration and Adaptation’ (DECCMA) project aims to provide policy makers with insight into the impact of different policy choices that specifically address adaptation to climate change. DECCMA’s geographical focus is on three deltas in Africa and Asia: the Volta in Ghana, the Mahanadi in India, and the Ganges-Brahmaputra-Meghna (GBM) spanning India and Bangladesh. However, this document has wider relevance for all deltas in the global south.

The Paris Agreement 2015 introduces an ‘ambition mechanism’ requiring countries to strengthen their commitments to adaptation and mitigation. Adaptation policy is a newly emerging area for most countries. As countries grapple with the possible contents of adaptation policy, it is worth reflecting on how different combinations of adaptation policy choices could affect adaptation futures. The aim of this paper is to consider what adaptation policy futures may look like, by developing four adaptation policy trajectories for the DECCMA project. These trajectories simply present realistic and feasible bundles of choices that could be made under different combinations of government investment and levels of political commitment to radical change. The trajectories are heavily influenced by the adaptation policy bundles described in Chapman et al. (2016), and building on the work of Hall et al. (2016)

This working paper first provides an overview of the intellectual framework that underpins the adaptation policy trajectories (section 2). We then present the method used to develop the trajectories, beginning with a description of the level of government investment and commitment to significant policy change involved with each of the trajectories (section 3), before providing a more complete narrative of each trajectory, including the specific adaptation policies that they rely on (section 4). This is followed by a reflection on the limitations of the work (section 5) before we draw some general conclusions (section 6).

2. Adaptation theory underpinning the trajectories

In this section we provide an overview of the adaptation framework used in the DECCMA project. This framework unpins the development of the adaptation policy trajectories. The DECCMA project defines adaptation as “any choices or adjustments to climate variability and change, these adjustments may be in response to, or in anticipation of, real or perceived climate stressors” (Nicholls et al., 2017)

Building on the work of Eakin et al. (2009) (following McGray et al., 2007), we create a simple high level typology of adaptation; categorising by purpose. We consider that the main aim of adaptation is to: (1) address drivers of vulnerability; (2) reduce disaster risk (DRR); and, (3) build landscape/ecosystem resilience. For each of the three broad categories we create sub-components of adaptation, to allow us to document more precise types of adaptation within each trajectory

(Figure 1). These sub-components draw on three well-developed theoretical constructs: the sustainable livelihoods framework (DfID, 1999), the disaster risk reduction cycle (UNISDR, 2005, UNISDR, 2015) and ecosystem services (MEA 2005). Collectively these theories allow us to consider adaptation decision making at multiple spatial scales, across multiple environments (from human to natural), and at multiple administrative scales (household to national).

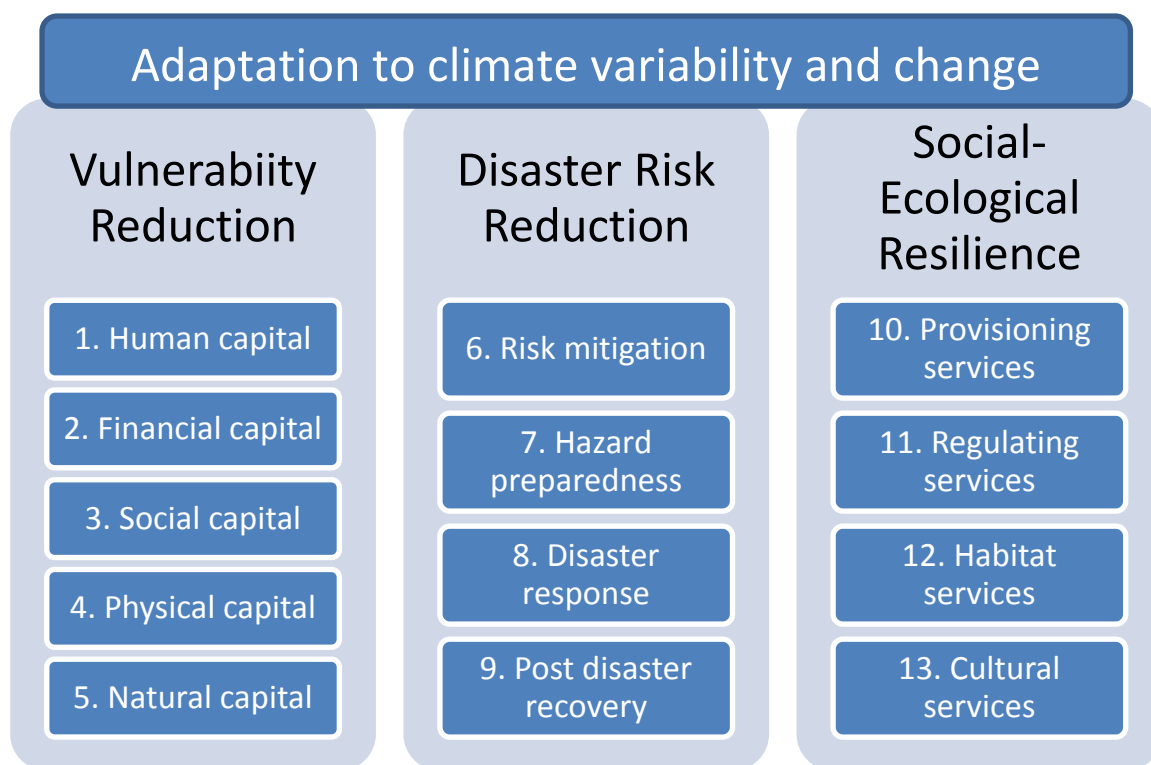


Figure 1: Components and sub-components of the adaptation policy trajectories

As with any typology, there are inevitably overlaps between categories. To address the issue of overlaps, we have slightly modified the focus of some of the 13 sub-components. For example there is overlap between ‘natural capital’ and ‘provisioning services’. To address this we include ‘natural capital’ adaptations only where the adaptation actively influences livelihoods and relates to land access and ownership. In contrast the ‘provisioning services’ adaptations relate to the production of goods and services by the land. In the following sections, we provide detailed descriptions of the three broad components and 13 sub-components of the framework.

2.1 Addressing drivers of vulnerability

A commonly used framework to document measures that reduce the drivers of vulnerability, is the five capitals component of the Sustainable Livelihoods Framework (SLF). The SLF was formed as a central concept of the UK’s Department for International Development’s (DFID) poverty alleviation strategy, which aims to “create sustainable livelihoods for poor people, promote human development and conserve the environment” (DfID, 1997: 6). These five capitals are the first five measures of adaptation in our framework. In the context of DECCMA, they are defined as:

1. Financial Capital - Regular inflows of money and savings that households have available, including loans and insurance
2. Human Capital - Skills, health and ability to labour of members of a household
3. Social Capital - Networks, relationships and membership of groups that households can use
4. Natural Capital – Land ownership and access to natural resources and storage facilities
5. Physical Capital - Infrastructure and goods such as tools and equipment that households can use to increase productivity and non-productive assets of the households (e.g. house material)

2.2 *Disaster Risk Reduction (DRR)*

To document adaptations that address DRR, we use a framework initiated by the UNISDR at Yokohama (UNISDR, 1994), and more recently developed in the Sendai framework (UNISDR, 2015). The Sendai framework aims for “The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.” (UNISDR, 2015). We group DRR into four components. These are:

1. Managing long term risk - efforts to build physical and social infrastructure that mitigate the worst impacts of an event. These can be one off activities, for example, building a sea wall, cyclone shelters, or on-going initiatives, e.g. developing flood risk management plans or relocating communities.
2. Preparedness – efforts to ensure communities are ready to respond to an event. These activities take place cyclically, for example, ensuring sea walls are maintained, practicing evacuation drills, or testing early warning systems.
3. Response – efforts to ensure affected households, communities, business and services receive appropriate assistance during and immediately following an event, e.g. evacuation support, first aid medical supplies, emergency responders
4. Post disaster recovery and rehabilitation – efforts to ensure affected households, communities, business and services are able to rebuild following an event, e.g. rehousing, reconstruction, and rebuilding/repairing houses and critical infrastructure.

2.3 *Landscape/ecosystem resilience*

To group adaptations that address landscape/ecosystem resilience, we used the CGIAR (2014) Ecosystem Services and Resilience Framework. Following CGIAR (2014) and Walker and Salt (2012) we define ecosystem services as the combined actions of natural processes that perform functions of value to society. There are four components to this framework:

1. Provisioning services – these are ecosystem goods that can be directly consumed, such as food, water, raw materials (e.g. fibre, biofuel, ornamental items), but also adaptations that enhance these services such as the use of irrigation and fertiliser.
2. Regulating services – these services keep the wider planetary systems (such as the atmosphere, cryosphere, oceans) functioning and include the regulation of climate, air, nutrient cycles and water flows; moderation of extreme events; treatment of waste – including water purification; preventing erosion; maintaining soil fertility; pollination; and biological controls, such as pests and diseases.

3. Habitat services – these maintain the life cycles of species or maintain genetic diversity, through quality and quantity of suitable habitats. In turn, these habitats underpin the health of provisioning and regulating services.
4. Cultural services – these services include aesthetic, recreational and tourism, inspirational, spiritual, cognitive development and mental health services provided by ecosystems.

3. Creating the adaptation policy trajectories (APTs)

Two core issues that relate to access to finance and political-will within state level institutions underpin the development of the adaptation policy trajectories (APTs). Thus we build four distinctly different and plausible policy trajectories to be explored in DECCMA around different levels of: (i) commitment to significant policy change; and (ii) financial investment in adaptation (Figure 2).

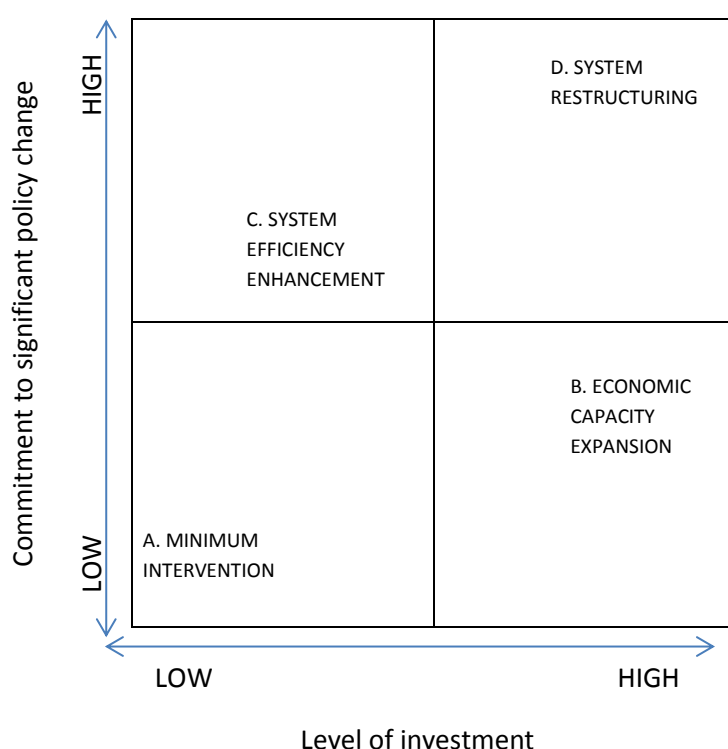


Figure 2: Investment and commitment to change within the adaptation policy trajectories

Where levels of investment are low, and there is low commitment to policy change, we identify APT **A. Minimum Intervention**. Where levels of investment are high, but there is low commitment to significant policy change, we identify APT **B. Economic capacity expansion**. In cases where there are medium levels of investment, and medium levels of commitment to policy change, we identify APT **C. System Efficiency Enhancement**. Finally, where commitment to change is high and levels of investment in change are high, we identify APT **D. System Restructuring**. More detail is now provided about each of the APTs.

- A. *Minimum Intervention* – is a no-regrets strategy where the most simple adaptation policies are pursued. This trajectory aims to keep adaptation costs down at the lowest possible level

while still protecting citizens from some climate change impacts. This requires low levels of commitment to policy change and the promotion of adaptations that require little investment. This is a no regrets strategy that aims to pick the low hanging fruit.

- B. *Economic Capacity Expansion* – encourages climate-proof economic growth but does not seek to make significant change to the current structure of the economy. A high level of investment is required to prepare the economy for future change, but adaptation policy does not aim to reorient the economy, or create significant change. Instead, the focus is on climate proofing industry and enhancing ability to adapt to changes.
- C. *System Efficiency Enhancement* – is an ambitious strategy that promotes adaptation consistent with the most cost efficient management and exploitation of the current system. As this policy trajectory is about keeping spending under control, there is limited investment compared to the other adaptation policy trajectories; however, there is a relatively high commitment to significant policy change as the system moves toward supporting people to adapt to long term change.
- D. *System Restructuring* – embraces pre-emptive fundamental change at every level in order to completely transform the current social and ecological system, and change the social and physical functioning of the delta system. Within this broad trajectory are three possible directions which each seek a different end goal. These are protect, accommodate and retreat.
 - (*Protect*) through significant landscape changes to *protect* traditional agricultural livelihoods
 - (*Accommodate*) through significant livelihood changes in order to *accommodate* changes to the natural environment
 - (*Retreat*) through policy led *abandonment* or *retreat* of people from the delta. This requires a high level of investment and a high commitment to significant policy change.

The relative importance of each of the adaptation components and sub-components within each trajectory is determined by the allocation of ‘points’ across the adaptation sub-components (Table 1). Experts in the field of adaptation, engineering, systems modelling, geography, identified how many ‘points’ should be allocated under each level of investment identified in Figure 2. We allocate 20 points for low investment, 30 points for medium investment and 40 points for high investment. Hence APT A has 20 points; APT B has 40 points, APT C has 30 points and APT D has 40 points. These arbitrary amounts are used for constraining the quantities of adaptations under each trajectory.

The same group of experts determined what ‘significant policy change’ meant for each APT by allocating the 20/30/40 points across the 13 adaptation categories, and highlighting the key priorities of that ‘world’. Low commitment to policy change permitted up to six adaptations. Medium to high commitment to policy change permits investment in up to nine aspects of adaptation. Using this approach, the least costly trajectory, the Minimum Intervention trajectory, spreads limited resources (20 points) across six of the 13 adaptation policy components. However, one of the three most ambitious trajectories, System Restructuring (Retreat) divides more substantial resources (40 points) across just three components and uses half of its significant

resources on post disaster recovery and rehabilitation alone. Using this weighting system it was possible to identify policy areas for investment, and levels of investment.

Table 1: DECCMA conceptual framework of adaptation

Broad category of adaptation	Component	A. Minimum intervention	B. Economic capacity expansion	C. System efficiency	D. System restructuring		
					Protect	Accommodate	Retreat
Addressing drivers of vulnerability	Financial capital	0	8	0	3	15	10
	Human capital	5	7	6	3	15	10
	Social capital	0	0	6	0	0	0
	Natural capital	0	0	4	3	0	0
	Physical capital	0	5	0	0	0	0
DRR	Managing long term risk	1	4	4	20	10	10
	Preparedness	4	2	3	0	0	0
	Response	2	2	0	0	0	0
	Post disaster recovery and rehabilitation	2	2	0	0	0	10
Landscape/ ecosystem resilience	Provisioning	6	5	3	10	0	0
	Regulating	0	5	1	1	0	0
	Habitat	0	0	1	0	0	0
	Cultural	0	0	2	0	0	0
	Total investment	20	40	30	40	40	40

4. Populating the adaptation policy trajectory narratives with adaptations

In this section we provide more detail on each of the adaptation policy trajectories, including a discussion of the specific adaptation interventions (see table 2) that are likely to occur within each of the trajectories.

4.1 Adaptation policy trajectories

4.1.1 Minimum Intervention

This trajectory aims to keep costs to the lowest possible level while still protecting citizens from climate change impacts. This trajectory reflects either a fundamental preference for a non-interventionist government, or a government lacking ambition or the capacity to act. It may also reflect the position of a government who feel that no further action is required. Any interventions involve simple initiatives that involve minimum financial investment. There is little planning for climate events, instead, the government provides a basic emergency response. See Table 3, for more details of the specific adaptation interventions in the minimum intervention trajectory.

- *Vulnerability* is reduced through investing in human capital, for example basic training on how to increase income at the household level, such as learning new farming or fishing techniques. There is little or no investment in other forms of capital.

- *DRR* is delivered through investment in medium term preparedness to warn people about hazards. Resources are also directed toward immediate contingency and disaster response, such as temporary evacuation, use of emergency responders and the secondment of army or national resources. Post disaster recovery and rehabilitation is limited providing very basic services, such as post disaster mobile water treatment plants and post disaster house construction for the worst affected households. Efforts to manage long term risk are limited to small scale community interventions that can be delivered through basic training, such as floating gardens that provide food during a flood.
- *Ecosystem resilience* is delivered through some basic provisioning services, which are partially supported through training such as potable water management. There is no support for other ecosystem services.

4.1.2 *Economic Capacity Expansion*

This trajectory focuses primarily on encouraging climate proof economic growth. A high level of investment is required, but adaptation policy does not aim to create an ambitious transformative change due to limited commitment to policy changes on adaptation. Instead, the focus is on climate proofing industry and enhancing adaptation without making significant policy changes. See Table 4, for more details of the specific adaptation interventions in the economic capacity expansion trajectory.

- *Vulnerability* reduction is the main focus of this trajectory with the prime focus is on improving financial capital. This is done at the household level, for example through government provided loans, agriculture and fisheries based insurance schemes and training on post-harvest production and storage. It is also done at the government level, for example, by encouraging private sector investment in ecotourism. There is also an emphasis on human capital as the government invests in training that in turn will ensure households are able to better participate in the non-farm economy, and on physical capital by ensuring that appropriate infrastructure exists to support economic growth e.g. roads and storage
- *DRR* focuses on long term risk mitigation, which can be through hard and soft measures. For hard DRR there might be a focus on the provision of river/coastal infrastructure to protect economically important areas. For soft DRR, preparedness and risk mitigation, for example through insurance, are considered. Post-disaster recovery efforts focus on getting the economy functioning quickly after disasters and reducing the impact of natural hazards on economic sectors. For example, funds available to rebuild damaged economic resources such as ports, roads and key grain stores
- *Ecosystem resilience* is delivered through investment in provisioning services. This is to enable income from food and water production under future climate change, for example, saline tolerant crops that can withstand coastal flooding. There is also a focus on regulating services, for example the use of agro-chemicals or creation of private sector incentives for tree planting.

4.1.2 *System Efficiency Enhancement*

This trajectory focuses on promoting most efficient management and exploitation of the current system, looking at ways of distributing labour, balancing livelihood choices, and best utilising ecosystem services to enhance livelihoods and wellbeing under climate change. It requires less

investment than other interventionist trajectories (i.e. economic capacity enhancement and system restructuring), but is relatively ambitious as the overall aim is to support people in the long term. See Table 5, for more details of the specific adaptation interventions in the system efficiency enhancement trajectory.

- *Vulnerability* is reduced by focusing on human and social capital at the household and community level. In terms of human capital, livelihood diversification in farming is promoted as is the teaching of climate resilient farming and post-harvest production methods. In terms of social capital, local farming and fishing cooperatives ensure maximum production benefits. Finally, by improving access to natural capital, for example through fishing permits, households are able to make the most efficient use of income generating resources.
- *DRR* is provided through investments in long term risk management using low cost interventions such as early warning systems, development of building codes for buildings in at risk areas and no build zones and government funds to reduce risks to agriculture (such as government run Agriculture Disaster Mitigation Funds). There is also a focus on preparedness. Communities are trained to prepare for events through relatively low cost initiative, such as DRR education at school, evacuation training and stakeholder engagement in DRR plans. There is little emphasis on response or recovery.
- *Ecosystem resilience* is a priority as it supports efficient management and exploitation of the delta system. All four ecosystem services are recognised as contributing to wider system efficiency and all are the focus of government interventions. The focus is on low cost interventions. In terms of provisioning, mixed land use and irrigation are promoted. In terms of regulating, tree planting, including mangroves, is the main focus. In terms of habitat, biological corridors are created, as are green spaces with native grass along waterways. Finally, in terms of cultural services the conservation of wildlife and biodiversity including sacred groves is promoted.

4.1.4 System Restructuring

This trajectory embraces the possibility of fundamental change to the social and physical functioning of the delta system in response to serious threats to the delta. There is a guiding belief that significant/radical landscape modifications are justified to create long term system restructuring despite the short term costs that may be accrued, among some social groups, and some economic sectors. This trajectory incorporates three sub trajectories. The first is ‘protect’ broadly following the Dutch model with use of extensive protective infrastructure to protect the current status quo in terms of livelihoods. System restructuring could also mean, a ‘living with nature’ approach as is evolving in the Mississippi where livelihoods have significantly changed in order to ‘accommodate’ changes to the natural environment. The third sub-trajectory relates to ‘retreat’ or abandonment of the delta in terms of population, for example, through a policy of relocation. See Table 6, for more details of the specific adaptation interventions in the three sub trajectories of the system restructuring trajectory.

These are the least developed of the trajectories and require significant input from the country teams to ensure they are realistic, relevant and feasible in the three DECCMA countries.

4.1.4.1 System restructuring – Protect

This trajectory aims to significantly change the natural system to make sure that traditional, agricultural based livelihoods are protected from climate impacts.

- *Vulnerability* is reduced by focusing on financial, human and natural capital. In terms of financial capital the green belt is used for farming. In terms of human capital, climate resilient farming techniques are promoted, and in terms of natural capital, land is redistributed to poorer farmers and small-scale fishers receive fishing rights.
- *DRR* is the main focus with all emphasis on managing long term risk through, for example, raising of land using controlled sedimentation, the creation of dams to manage flood water, no build zones, land zoning and massive investment in river/coastal infrastructure.
- *Ecosystem resilience* is a priority as the aim of this trajectory is to allow traditionally based agricultural livelihoods to continue. In terms of provisioning, significant land use changes and use of climate tolerant crops allow farming to continue. In terms of regulating, river course management and strict rules around forest use also allow farming to continue.

4.1.4.2 System restructuring – Accommodate

This trajectory aims to significantly change livelihoods (i.e. move away from traditional agricultural activities) to ensure the population can remain in the delta.

- *Vulnerability* is reduced by significantly focusing on financial and human capital. In terms of financial capital, there is an effort to promote non-farm industry within the delta, such as private sector investments in eco-tourism through economic incentives.
- *DRR* focuses on managing long term risk. Specifically, investment in river/coastal infrastructure to protect new industry, but there is no drive to protect current agriculture.
- *Ecosystem resilience* is not a priority as land is not used for provisioning.

4.1.4.3 System restructuring – Retreat

This trajectory aims to encourage population movement out of the delta.

- *Vulnerability* is reduced by significantly focusing on financial and human capital. In terms of financial capital, this may include financial incentives to relocate outside of the delta. In terms of human capital, this may include farmer investment in training for new non-delta livelihoods/social mobility and individual choice.
- *DRR* focuses on post disaster recovery and rehabilitation. Specifically, the use of relocation outside of the delta following an event. There is also an emphasis on dealing with long term risk as people are located permanently outside of the delta.
- *Ecosystem resilience* is not a priority as land is not used for provisioning.

4.2 Adaptation interventions

Adaptation interventions were identified using three methods. First, teams of DECCMA adaptation experts in each DECCMA country (Bangladesh, Ghana, and India) performed coordinated searches of the empirical literature to generate lists of observed adaptations. The output of these searches generated an inventory of 122 adaptations that are described in Tompkins et al. (2017). Second, the DECCMA teams of experts in each DECCMA country conducted a review of current and proposed adaptation policy in the study areas (Dey et al., 2016., Ghosh et al., 2016, Haq et al., 2015, Hazra et al., 2016, Mensah et al., 2016). Third, a literature search was undertaken on transformative adaptation to document the types of adaptations that could be considered radical, and significantly large to restructure an entire delta system (Vincent, 2017). From this combined search, almost 200 adaptation types were identified. These were then categorised into adaptations that would be undertaken autonomously by households, and those that would be undertaken by the government. Government-led adaptations were then grouped into 68 discrete options (Table 2). These 68 adaptation options were then allocated among the four APTs, by and expert groups, who considered the relative levels of investment for each and whether this would represent a significant policy change for each delta.

Table 2: list of interventions categories by 3 main components

Addressing drivers of vulnerability
<ol style="list-style-type: none"> Promoting livelihood diversification (farming) Switch livelihoods (from farming to off farm) Promoting livelihood diversification (fishing) Promoting livelihood diversification - off-farm activity) Livelihood diversification – fishing Agricultural extension officer who provide basic training on how to increase income at the household level, such as learning new farming or fishing techniques. Development of non-farm industry Existence of loans at government level Incentives for migration to economic expansion areas Financial incentives to relocate outside of the worst affected parts of the delta Promote private sector investments in eco-tourism through economic incentives Establish agriculture and fisheries based insurance schemes Post-harvest production and storage at local level (e.g. farmer level) Develop and use open spaces, green belts and other ecologically sensitive areas for alternative livelihood such as urban farming Use of climate resilient farming techniques Farmer led cooperatives that reduce the cost of production/distribution Access to markets for all, including infrastructure, training Fishing zones/rights for small-scale fishers Land reclamation and redistribution (to the poor or other groups)
Disaster Risk Reduction
<ol style="list-style-type: none"> All-Risk-changing-modifications to homes (height of foundations/walls/floors e.g. climate resilient cluster housing) and local facilities (raise water sources and sanitation facilities above the flood level) through funding, loans and new building codes. Raising of land using controlled sedimentation Creation of dams to manage flood water

23. No build zones
24. Land zoning
25. Education at school level re. responsibilities for DRR management e.g. evacuation training
26. Active stakeholder engagement in design and delivery of DRR
27. Communication and information re. individual roles and responsibilities re DRR
28. Readiness of emergency services to distribute medicines, food and potable water
29. Availability of DRR insurance
30. Early warning systems
31. Rehabilitation and upgrading of reservoirs for water (e.g. dredging, raising spillway levels)
32. Government funds to reduce risks to agriculture (Government run Agriculture Disaster Mitigation Fund)
33. Multipurpose shelters including flood and cyclone shelters
34. Invest in river/coastal management infrastructure
35. Climate proof grain silos/storage (at national and local level)
36. Ensure food availability during flood (e.g. Floating gardens and hanging vegetable garden)
37. Train community in DRR management
38. Train community in water management
39. Maintain existing infrastructure
40. Initiatives to get the economy running quickly, e.g. funds available to rebuild damaged economic resources such as ports, roads and grain stores
41. Temporary evacuation
42. Use of emergency responders
43. Secondment of army or national resources
44. Post disaster mobile water treatment plants
45. Post disaster house construction
46. Government supported relocation of households outside of the worst affected parts of the delta

Landscape/ ecosystem resilience

47. Climate tolerant crops
48. Using different crop varieties
49. Seed bank for crop diversification
50. Climate tolerant aquaculture
51. Alternative climate proof grasses for cattle
52. Mixed land use (e.g. polder and shrimp farm with rice)
53. Changing irrigation practices for farming
54. Potable water management
55. Promote saline tolerant trees to prevent erosion around farms and homes
56. Use of agro-chemicals to boost agricultural productivity and treat salinity
57. River course management
58. Mangrove forest planting
59. Agroforestry
60. Afforestation - Promote ecological restoration of degraded and poorly stocked forests
61. Tree planting in public areas
62. Create incentives for investor in tree crops and plantation (tax relief for private sector investment in research and development)
63. Reduce the pressure on forests for wood-fuels by encouraging use of renewable energy
64. No commercial mining in forested areas
65. Afforestation – climate tolerant bamboo
66. Create biological corridors between existing of conservation areas to maintain gene flows
67. Promote establishment of protected green spaces with native grass along waterways

68. Conservation of wildlife and biodiversity in natural heritage sites including sacred groves, protected areas

To populate the adaptation policy trajectories, these 68 adaptations were then grouped by component of the DECCMA adaptation intellectual framework (13 components). Each adaptation can appear in more than one trajectory, but they do not appear in more than one component (see Tables 3, 4, 5 and 6). For example, the adaptation intervention ‘promote private sector investments in eco-tourism through economic incentives’ is a Ghanaian policy objective. This was assigned to component one, addressing drivers of vulnerability – financial capital. It was then assigned to the Economic Capacity Expansion trajectory as it offers a non-farm income generating activity, which sits alongside traditional farm based livelihoods. It was also assigned to the System Restructuring (Accommodate) trajectory as, along with a suite of other adaptations with a similar objective, it may enable a complete shift from farm based to non-farm based livelihood activities that are more suited to a changed environment.

5. Limitations

The methodology used to generate the adaptation inventory for each delta follows a method developed by (Tompkins et al., 2010), see Tompkins et al (2016). This method only identifies published work and as such, adaptations that have not been reported in the literature may have been missed. The list of adaptation interventions therefore may not reflect all the adaptations that are currently happening. A similar issue exists in terms of the adaptations that were generated through the policy reviews. For the policy reviews, a coordinated methodology was applied and this may have led to some sectors being omitted or relevant policies ignored.

6. Discussion and conclusion

This document provides a description of the adaptation policy trajectories planned for use in the DECCMA model. These trajectories document the possible sets of adaptation policies that might be combined to deliver a range of high level objectives. The trajectories are based on research on adaptation undertaken by all partners engaged in DECCMA, and indeed, their strength is that they are shaped around inputs from each of the DECCMA country teams who documented their country’s adaptation policy.

Each of the adaptation trajectories employs a different set of top-down, or policy-led, adaptation interventions. Although the adaptation trajectories focus only on adaptations that emerge from policy, it is likely that each adaptation trajectory will influence the choice of household-led adaptations. This interaction between policy choices and household adaptation will be explored in the DECCMA model that should be produced by 2018.

Table 3: Adaptation interventions under the minimum intervention trajectory

Broad category of adaptation	Component	Example of adaptation intervention
Addressing drivers of vulnerability	Financial capital	<i>Not a priority / component not active</i>
	Human capital	<ul style="list-style-type: none"> Examples absent from the data but may include: <ul style="list-style-type: none"> Agricultural extension officer who provide basic training on how to increase income at the household level, such as learning new farming or fishing techniques.
	Social capital	<i>Not a priority / component not active</i>
	Natural capital	<i>Not a priority / component not active</i>
	Physical capital	<i>Not a priority / component not active</i>
DRR	Managing long term risk	<ul style="list-style-type: none"> Ensure food availability during flood (e.g. Floating gardens and hanging vegetable garden)
	Preparedness	<ul style="list-style-type: none"> Train community in DRR management Train community in water management
	Response	<ul style="list-style-type: none"> Examples absent from the data but may include: <ul style="list-style-type: none"> Temporary evacuation Use of emergency responders Secondment of army or national resources
	Post disaster recovery and rehabilitation	<ul style="list-style-type: none"> Post disaster mobile water treatment plants Post disaster house construction
Landscape/ ecosystem resilience	Provisioning	<ul style="list-style-type: none"> Potable water management
	Regulating	<i>Not a priority / component not active</i>
	Habitat	<i>Not a priority / component not active</i>
	Cultural	<i>Not a priority / component not active</i>

Table 4: Adaptation interventions under the economic capacity expansion trajectory

Broad category of adaptation	Component	Example of adaptation intervention
Addressing drivers of vulnerability	Financial capital	<ul style="list-style-type: none"> Promote private sector investments in eco-tourism through economic incentives Establish agriculture and fisheries based insurance schemes Post-harvest production and storage Develop and use open spaces, green belts and other ecologically sensitive areas for alternative livelihood such as urban farming Examples absent from the data but may include: <ul style="list-style-type: none"> Existence of loans at government level Incentives for migration to economic expansion areas
	Human capital	<ul style="list-style-type: none"> Example absent from the data but may include: <ul style="list-style-type: none"> Education for STEM(non-farm livelihoods)
	Social capital	Not a priority / component not active
	Natural capital	Not a priority / component not active
	Physical capital	<ul style="list-style-type: none"> Access to markets for all, including infrastructure, training
DRR	Managing long term risk	<ul style="list-style-type: none"> Availability of DRR insurance Government funds to reduce risks to agriculture (Government run Agriculture Disaster Mitigation Fund) Multipurpose shelters including cyclone shelters Invest in river/coastal infrastructure (levee and river bank protection; Polder construction/improvement; Sea dyke/coastal polder improvement; Plan, design and construct urgently needed new infrastructure (e.g., cyclone shelters, coastal and river embankments and water management systems; urban drainage systems, river erosion control works, flood shelters); Embankment reconstruction) Climate proof grain silos/storage Ensure food availability during flood (e.g. Floating gardens and hanging vegetable garden)
	Preparedness	<ul style="list-style-type: none"> Maintain existing infrastructure (e.g., coastal embankments, river embankments and drainage systems, urban drainage systems)
	Response	<ul style="list-style-type: none"> Examples absent from the data but may include: <ul style="list-style-type: none"> Emergency aid provision Provision to ensure business and economic activities that support the economy receive

		<i>immediate attention</i> <ul style="list-style-type: none"> ○ <i>Critical infrastructure protection</i>
	Post disaster recovery and rehabilitation	<ul style="list-style-type: none"> ● <i>Examples absent from the data but may include:</i> <ul style="list-style-type: none"> ○ <i>Initiatives to get the economy running quickly, e.g. funds available to rebuild damaged economic resources such as ports, roads and grain stores</i>
Landscape/ecosystem resilience	Provisioning	<ul style="list-style-type: none"> ● Potable water management ● Climate tolerant crops (Saline tolerant crops; Use of drought and heat resistant crop varieties – e.g. drought tolerant peppers) ● Using different crop varieties ● Climate tolerant aquaculture ● Promote saline tolerant trees to prevent erosion around farms and homes ● Seed bank for crop diversification ● Alternative climate proof grasses for cattle
	Regulating	<ul style="list-style-type: none"> ● Use of agro-chemicals ● Create incentives for investor in tree crops and plantation (tax relief for private sector investment in research and development)
	Habitat	<i>Not a priority / component not active</i>
	Cultural	<i>Not a priority / component not active</i>

Table 5: Adaptation interventions under the system efficiency enhancement trajectory

Broad category of adaptation	Component	Example of adaptation intervention
Addressing drivers of vulnerability	Financial capital	<i>Not a priority / component not active</i>
	Human capital	<ul style="list-style-type: none"> • Use of climate resilient farming techniques • Livelihood diversification (farming) • Livelihood diversification (fishing) • Livelihood diversification - off-farm activity) • Post-harvest production and storage at local level (e.g. farmer led)
	Social capital	<ul style="list-style-type: none"> • <i>Examples absent from the data but may include:</i> <ul style="list-style-type: none"> ○ <i>Farmer led cooperatives that reduce the cost of production/distribution</i>
	Natural capital	<ul style="list-style-type: none"> • Fishing zones/rights for small-scale fishers
	Physical capital	<i>Not a priority / component not active</i>
DRR	Managing long term risk	<ul style="list-style-type: none"> • Early warning systems • All-Risk-changing-modifications to homes (walls/floors etc) - through funding and new building codes • Rehabilitation and upgrading of reservoirs for water (e.g. dredging, raising spillway levels) • Government funds to reduce risks to agriculture (Government run Agriculture Disaster Mitigation Fund) • Ensure food availability during flood (e.g. Floating gardens and hanging vegetable garden) • <i>Example absent from the data but may include:</i> <ul style="list-style-type: none"> ○ <i>No build zones</i> ○ <i>Land zoning</i>
	Preparedness	<ul style="list-style-type: none"> • <i>Examples absent from the data but may include:</i> <ul style="list-style-type: none"> ○ <i>Education at school level re. responsiveness for DRR management e.g. evacuation training</i> ○ <i>Active stakeholder engagement in design and delivery of DRR</i> ○ <i>Communication and information re. individual roles and responsibilities re DRR</i> ○ <i>Readiness of emergency services to distribute medicines, food and potable water</i>
	Response	<i>Not a priority / component not active</i>
	Post disaster recovery and rehabilitation	<i>Not a priority / component not active</i>

Landscape/ecosystem resilience	Provisioning	<ul style="list-style-type: none"> • Mixed land use (e.g. polder and shrimp farm with rice) • Changing irrigation practices for farming
	Regulating	<ul style="list-style-type: none"> • Mangrove forest planting • Promote the adoption of farm forestry practices, which include managing trees on farms, farm boundary planting and agroforestry systems (Ghana) • Promote ecological restoration of degraded and poorly stocked forests using appropriate reforestation/restoration techniques(ie enrichment planting, Assisted Natural Regeneration) • Tree planting in public areas • Reduce the pressure on forests for wood-fuels by encouraging use of renewable energy • Afforestation – climate tolerant bamboo
	Habitat	<ul style="list-style-type: none"> • Create biological corridors between existing of conservation areas to maintain gene flows • Promote establishment of protected green spaces with native grass along waterways
	Cultural	<ul style="list-style-type: none"> • Conservation of wildlife and biodiversity in natural heritage sites including sacred groves, protected areas • Protect sacred groves

Table 6: Adaptation interventions under the system restructuring trajectory

Broad category of adaptation	Component	Example of adaptation intervention		
		Protect	Accommodate	Retreat
Addressing drivers of vulnerability	Financial capital	<ul style="list-style-type: none"> Develop and use open spaces, green belts and other ecologically sensitive areas for alternative livelihood such as urban farming 	<ul style="list-style-type: none"> Promote private sector investments in eco-tourism through economic incentives Examples absent from the data but may include: development of non-farm industry 	<ul style="list-style-type: none"> Example absent from the data but may include: financial incentives to relocate outside of the delta
	Human capital	<ul style="list-style-type: none"> Use of climate resilient farming techniques 	<ul style="list-style-type: none"> Example absent from the data but may include: Education for STEM (non-farm livelihoods, based within the delta) 	<ul style="list-style-type: none"> Examples absent from the data but could include: Farmer investment in training for new non-delta livelihoods/social mobility and individual choice
	Social capital	Not a priority / component not active	Not a priority / component not active	Not a priority / component not active
	Natural capital	<ul style="list-style-type: none"> Land redistribution (to the poor or other groups) Fishing zones/rights for small-scale fishers 	Not a priority / component not active	Not a priority / component not active
	Physical capital	Not a priority / component not active	Not a priority / component not active	Not a priority / component not active
DRR	Managing long term risk	<ul style="list-style-type: none"> Example absent from the data but could include: Raising of land using controlled 	<ul style="list-style-type: none"> Invest in river/coastal infrastructure (levee and river bank protection; Polder 	<ul style="list-style-type: none"> Example absent from the data but may include forced relocation of communities outside of

		<i>sedimentation</i> <ul style="list-style-type: none"> • <i>Creation of dams to manage flood water</i> • <i>No build zones</i> • <i>Land zoning</i> • <i>Invest in river/coastal infrastructure (levee and river bank protection; Polder construction/improvement; Sea dyke/coastal polder improvement; Plan, design and construct urgently needed new infrastructure (e.g., cyclone shelters, coastal and river embankments and water management systems; urban drainage systems, river erosion control works, flood shelters); Embankment reconstruction)</i> 	construction/improvement; Sea dyke/coastal polder improvement; Plan, design and construct urgently needed new infrastructure (e.g., cyclone shelters, coastal and river embankments and water management systems; urban drainage systems, river erosion control works, flood shelters); Embankment reconstruction)	<i>the delta</i>
	Preparedness	<i>Not a priority / component not active</i>	<i>Not a priority / component not active</i>	<i>Not a priority / component not active</i>
	Response	<i>Not a priority / component not active</i>	<i>Not a priority / component not active</i>	<i>Not a priority / component not active</i>
	Post disaster recovery and rehabilitation	<i>Not a priority / component not active</i>	<i>Not a priority / component not active</i>	<ul style="list-style-type: none"> • <i>Example absent from the data but could include government supported relocation of</i>

				<i>people outside the delta following an event</i>
Landscape/ecosystem resilience	Provisioning	<ul style="list-style-type: none"> • Mixed land use (e.g. polder and shrimp farm with rice) • Changing irrigation practices for farming • Climate tolerant crops (Saline tolerant crops; Use of drought and heat resistant crop varieties – e.g. drought tolerant peppers) • Using different crop varieties • Climate tolerant aquaculture 	<i>Not a priority / component not active</i>	<i>Not a priority / component not active</i>
	Regulating	<ul style="list-style-type: none"> • River course management • Reduce the pressure on forests for wood-fuels by encouraging use of renewable energy • No commercial mining in forested areas 	<i>Not a priority / component not active</i>	<i>Not a priority / component not active</i>
	Habitat	<i>Not a priority / component not active</i>	<i>Not a priority / component not active</i>	<i>Not a priority / component not active</i>
	Cultural	<i>Not a priority / component not active</i>	<i>Not a priority / component not active</i>	<i>Not a priority / component not active</i>

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